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IGARSS 2002
NPOESS Workshop

MW I/S Ocean (I)

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Remote Sensing Systems
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CMIS Ocean EDR Retrievals

- Sea Surface Temperature (SST)
- Surface Wind Speed
- Surface Wind Direction
- Surface Wind Stress

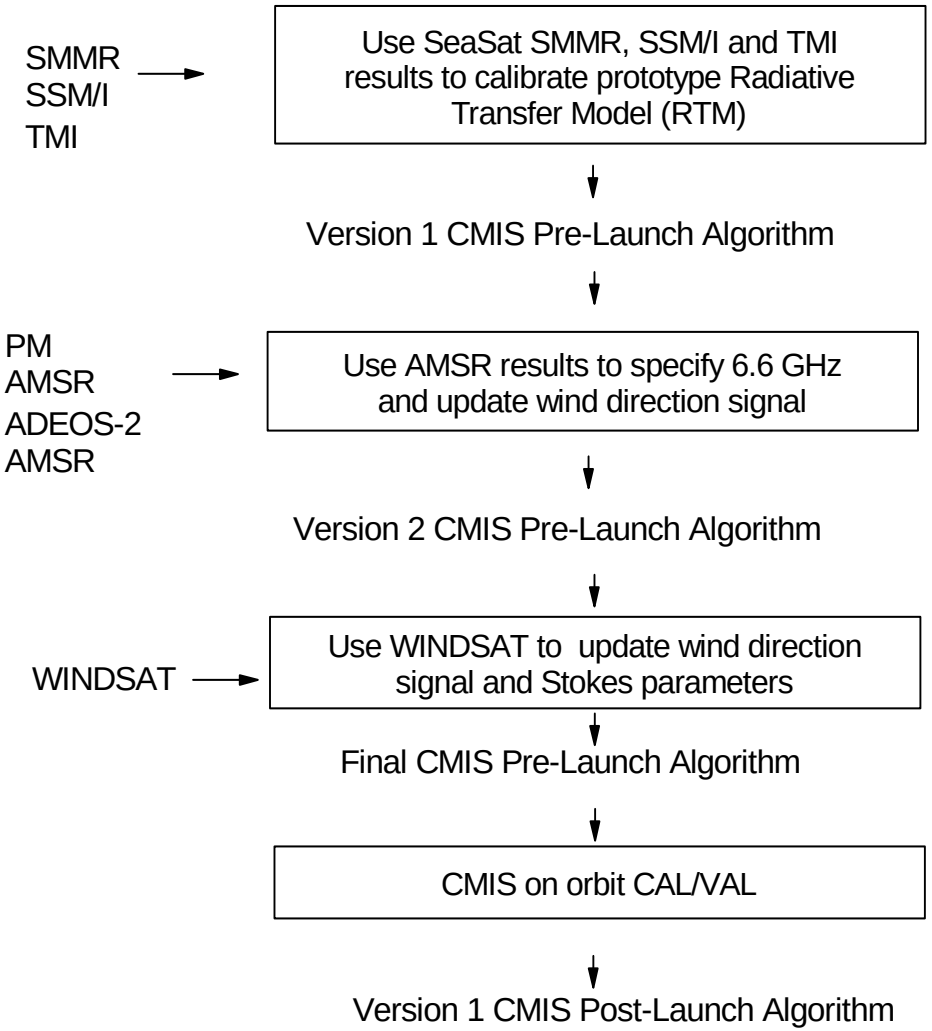
CMIS Configuration

Frequency [GHz]	6.6	10.7	18.7	23.8	36.5
POL	VH	VH LR	VH LR PM	VH	VH PM
EIA [deg]	55.79	58.16	53.62	53.62	55.79
Footprint [km x km]	68 x 39	46 x 25	24 x 16	24 x 16	17 x 10

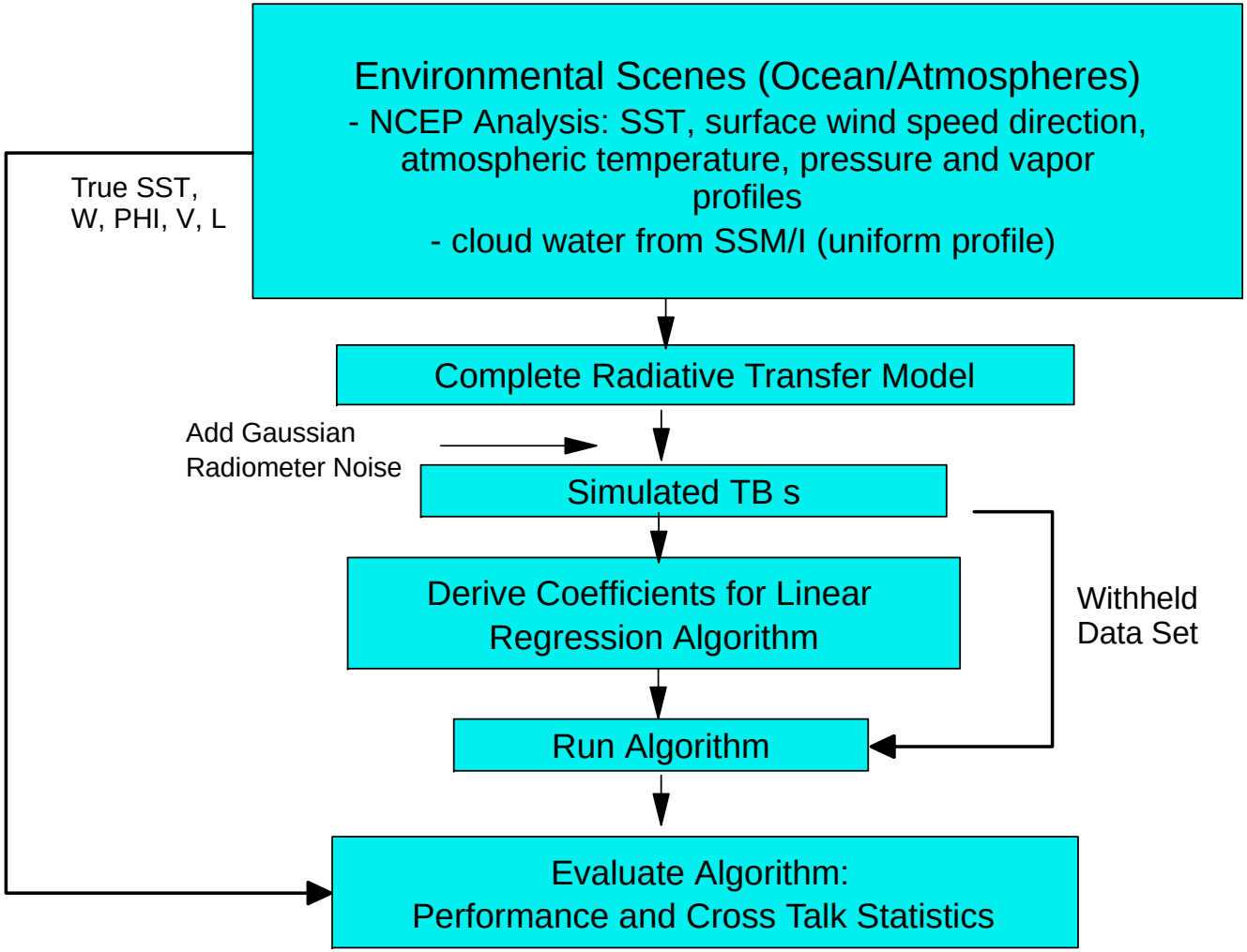
Channel Utilization and Resolution of Ocean EDR

SST	All 7 – 37 GHz	86 x 52 km
High Resolution Wind Speed + Wind Stress	18 – 37 GHz	20 x 20 km
Medium Resolution Wind Speed + Wind Direction	10 – 37 GHz	56 x 35 km

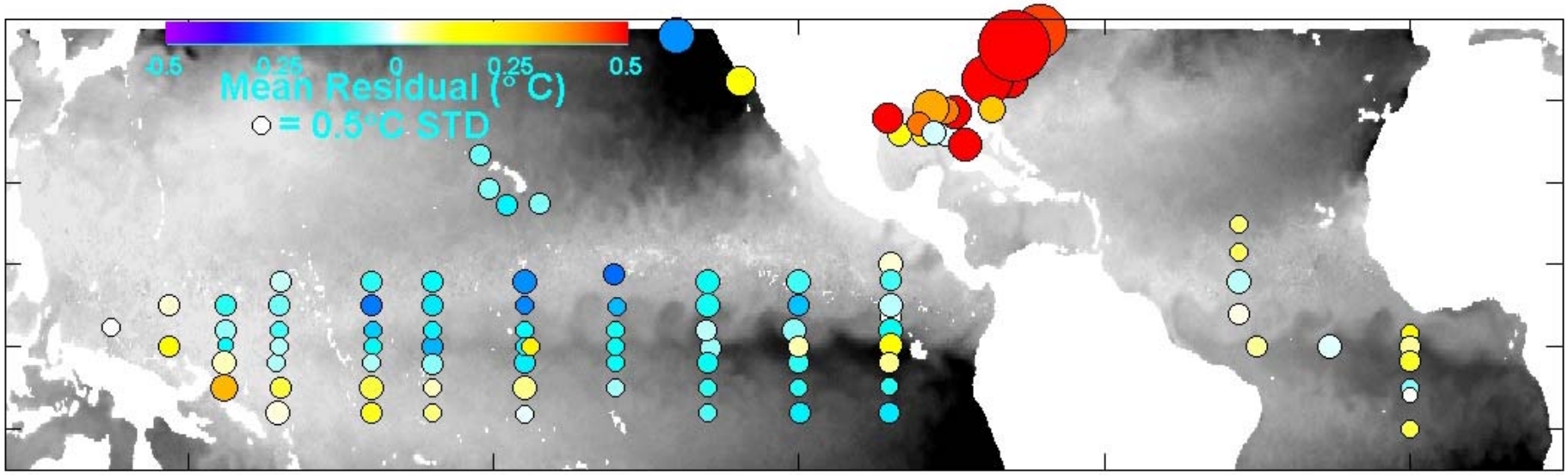
CMIS Algorithm Development Plan



Algorithm Development and Testing

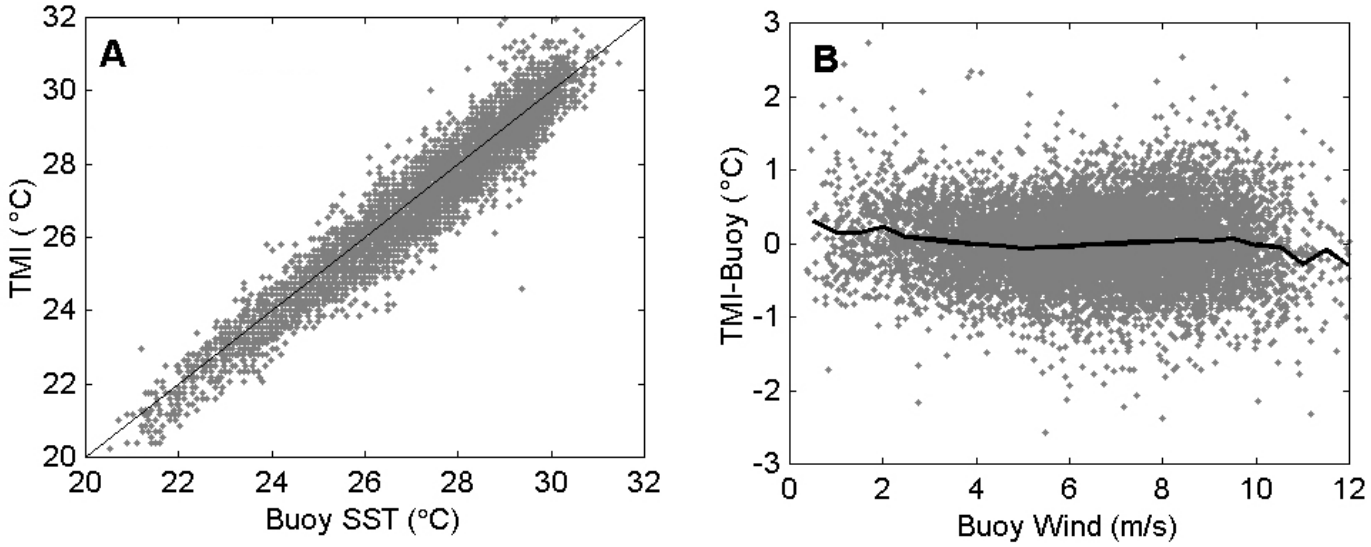


TMI SST Validation with Ocean Buoys



		Orbital Collocations TMI – Buoy SST	
	collocations	Mean Dif.	STD
TAO	28176	-0.08	0.57
PIRATA	4913	0.03	0.55
NDBC	19493	0.28	0.92

TMI SST Validation with Ocean Buoys



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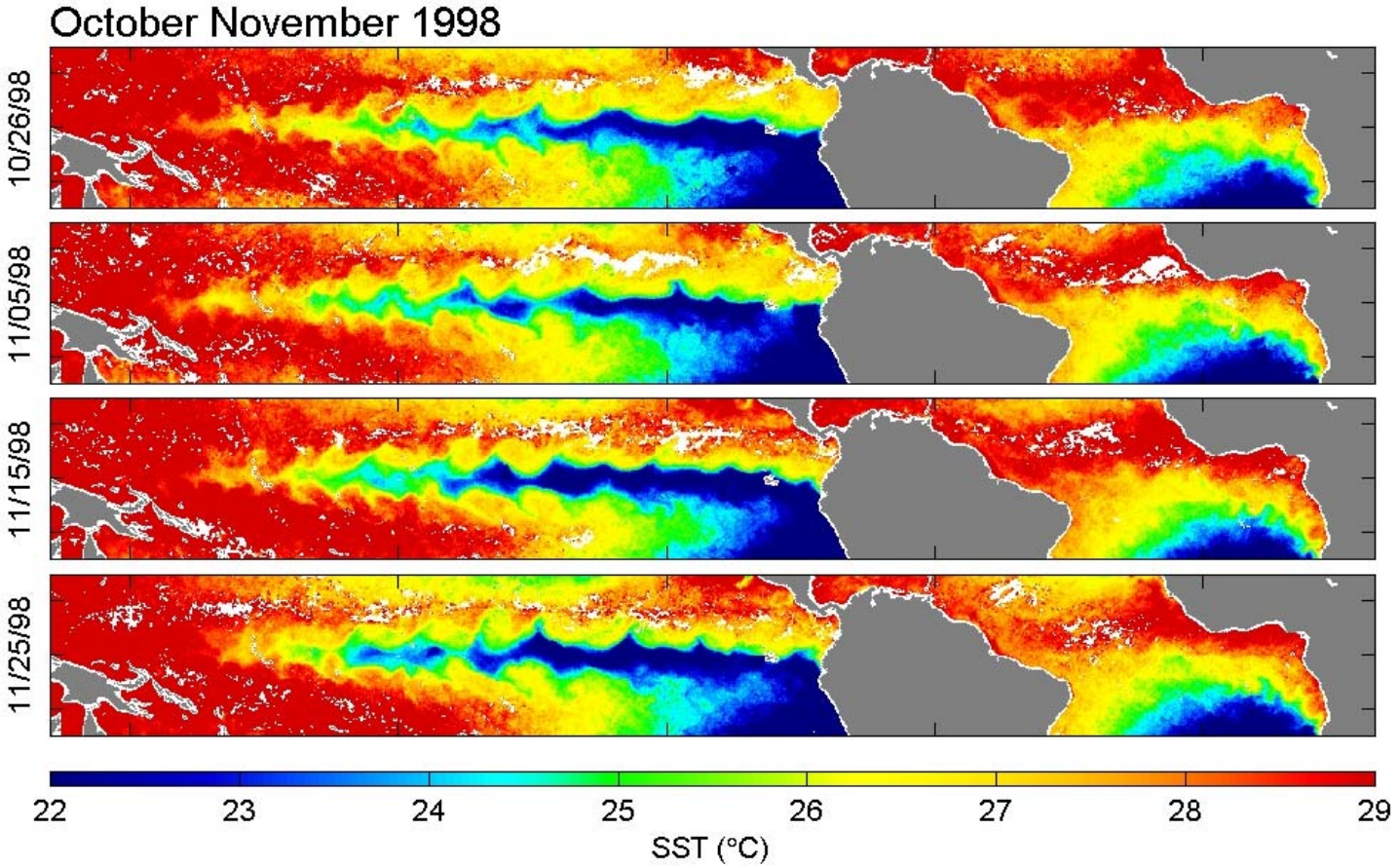
Tropical Instability Waves during the 1998 La Niña



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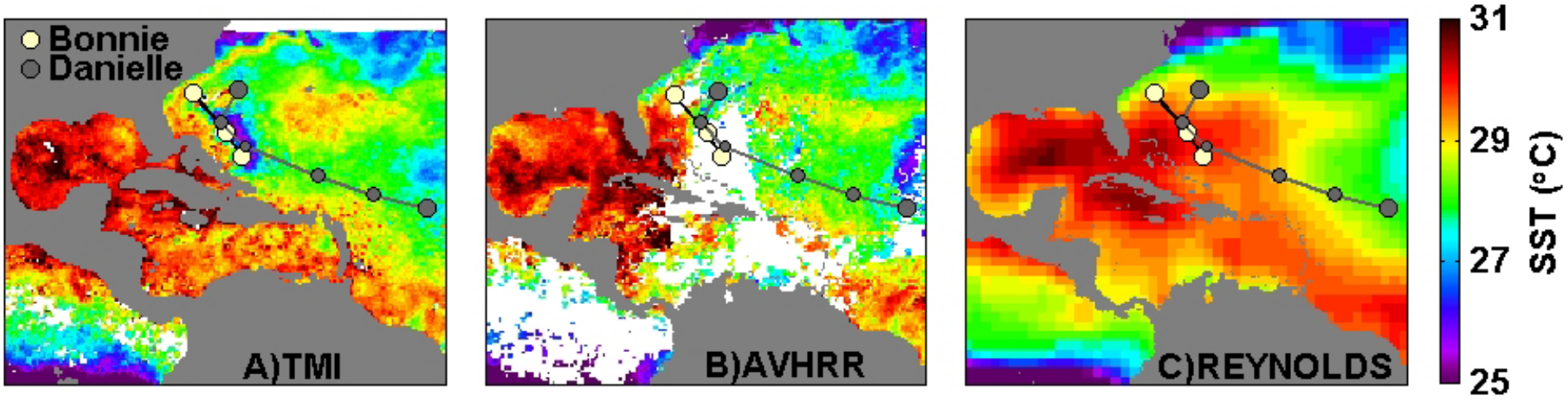
SST during Hurricane Danielle



- TMI views cold wake from Hurricane Bonnie
- AVHRR misses it due to cloud cover
- Reynolds lacks temporal/spatial resolution

SST with AMSR and CMIS

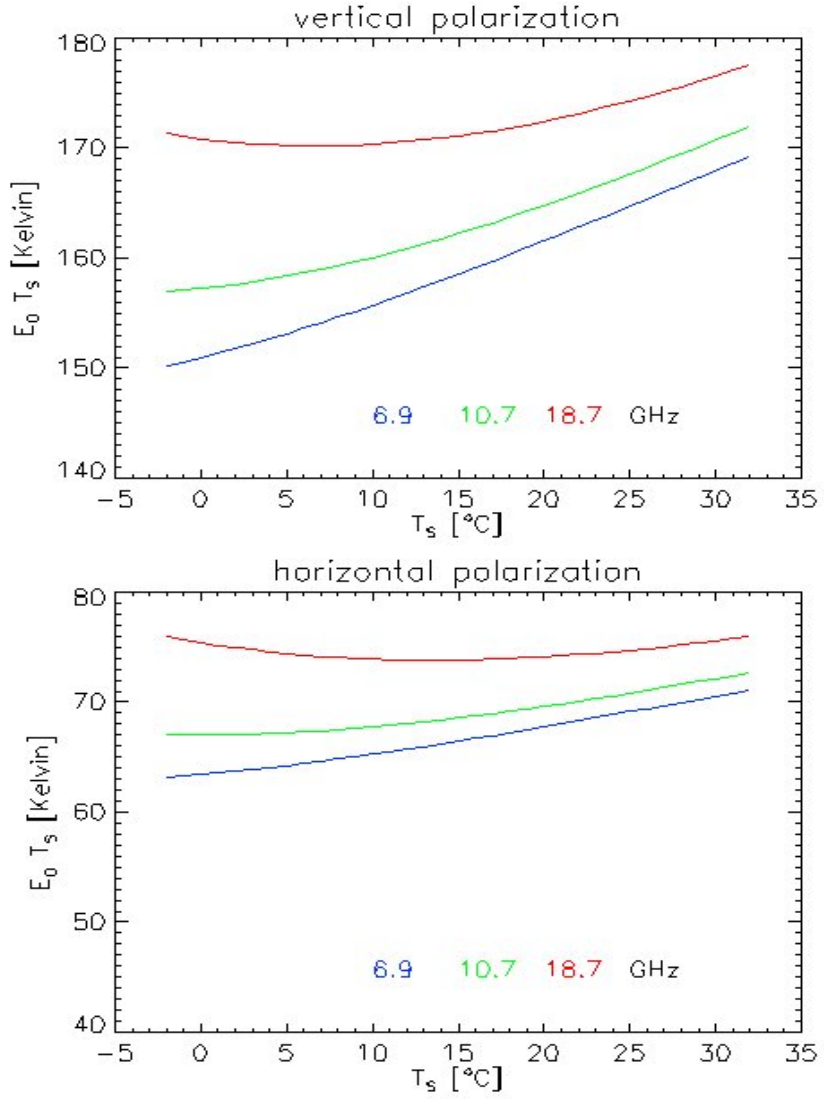
AMSR Configuration
6.9 VH 10.7 VH 18.7 VH 23.8 VH 36.5 VH 89.0 VH
Earth Incidence Angle (EIA): 55 deg
polar orbiting

CMIS Configuration
6.6 VH 10.7 VH 18.7 VH 23.8 VH 36.5 VH 89.0 VH
+ polarimetric channels: 10.7 LR 18.7 PMLR 36.5 PM
Earth Incidence Angle (EIA): 53 - 58 deg (frequency dependent)
polar orbiting

7 GHz channel allows SST retrieval in cold water

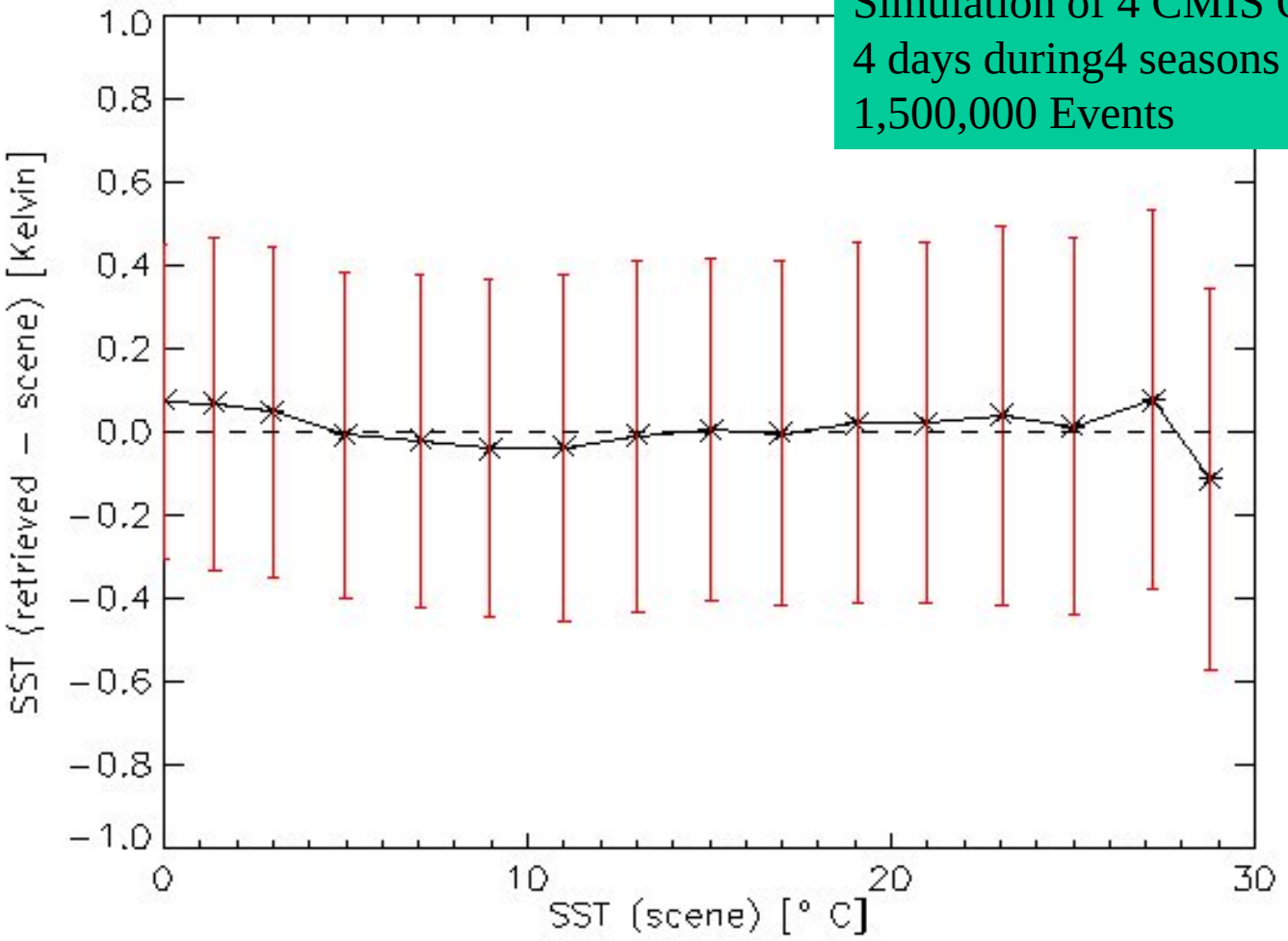
$T_S < 15^oC$

SST Signal of Radiated Brightness Temperature: E_0 (specular emissivity) * T_S



- All 6 – 37 GHz channels
- 86 km * 52 km resolution

Simulation of 4 CMIS Orbits
4 days during4 seasons
1,500,000 Events

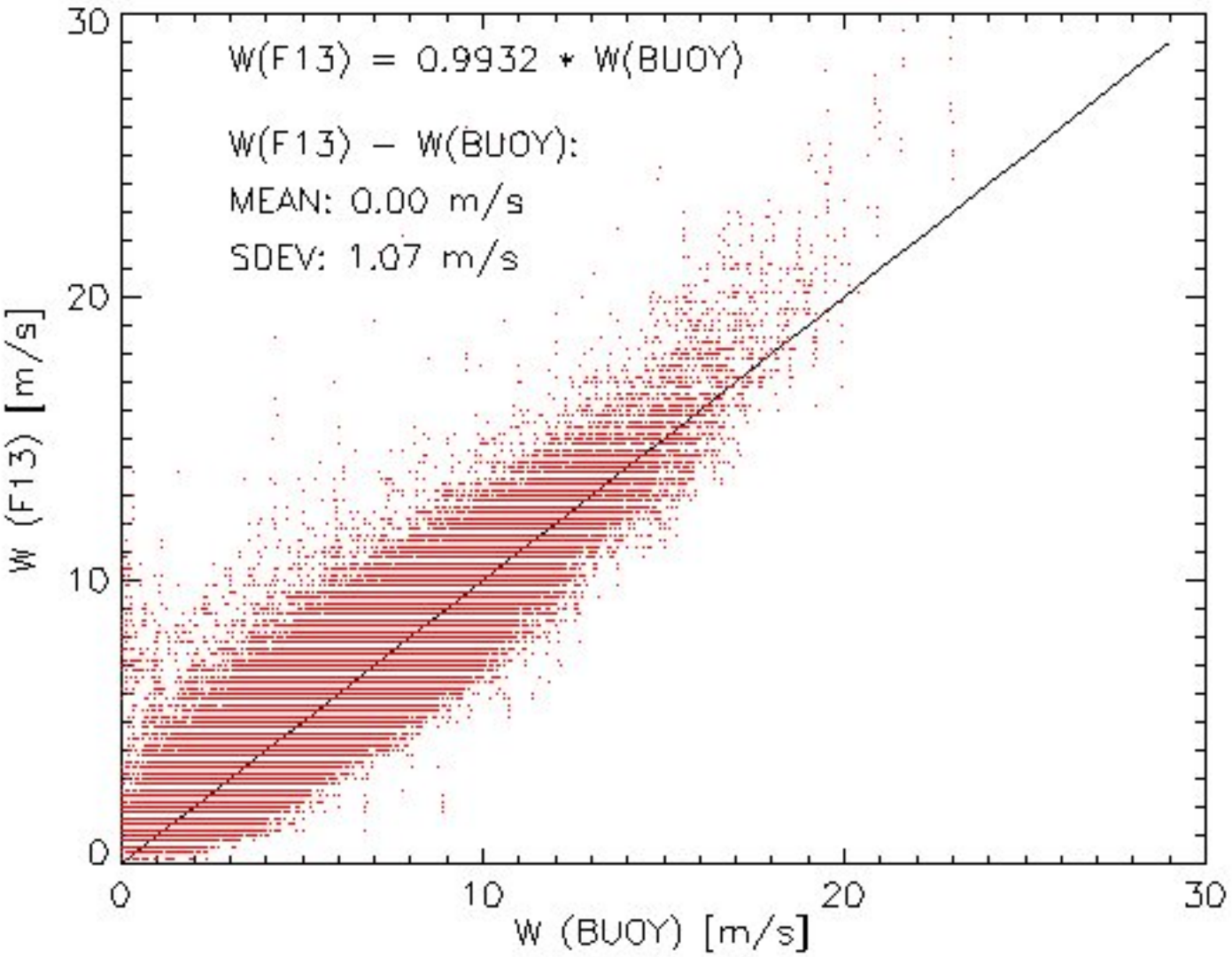


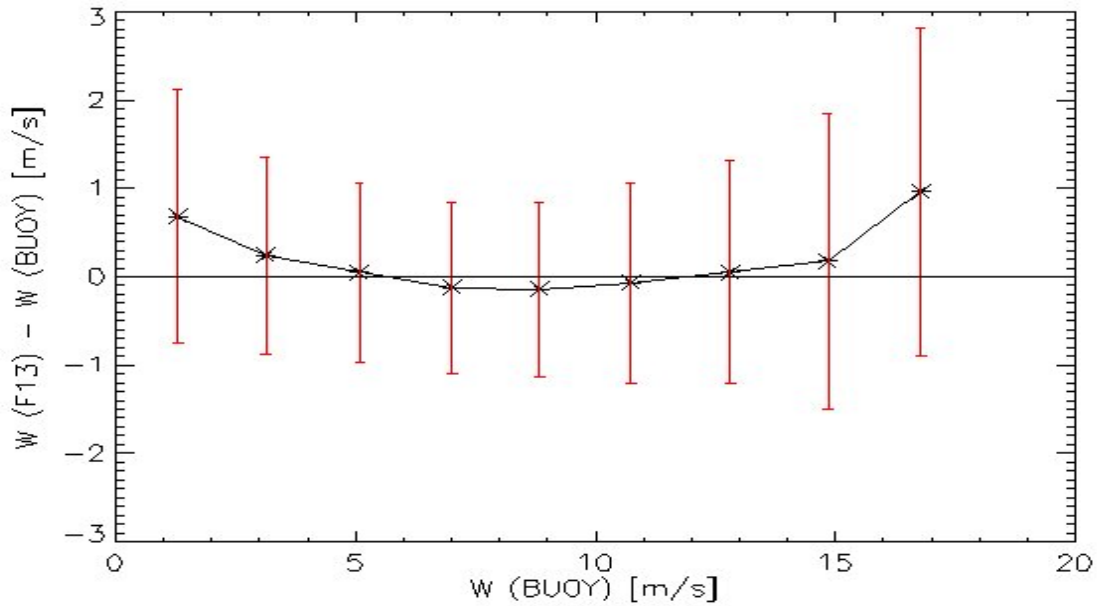
Wind Speed Algorithm

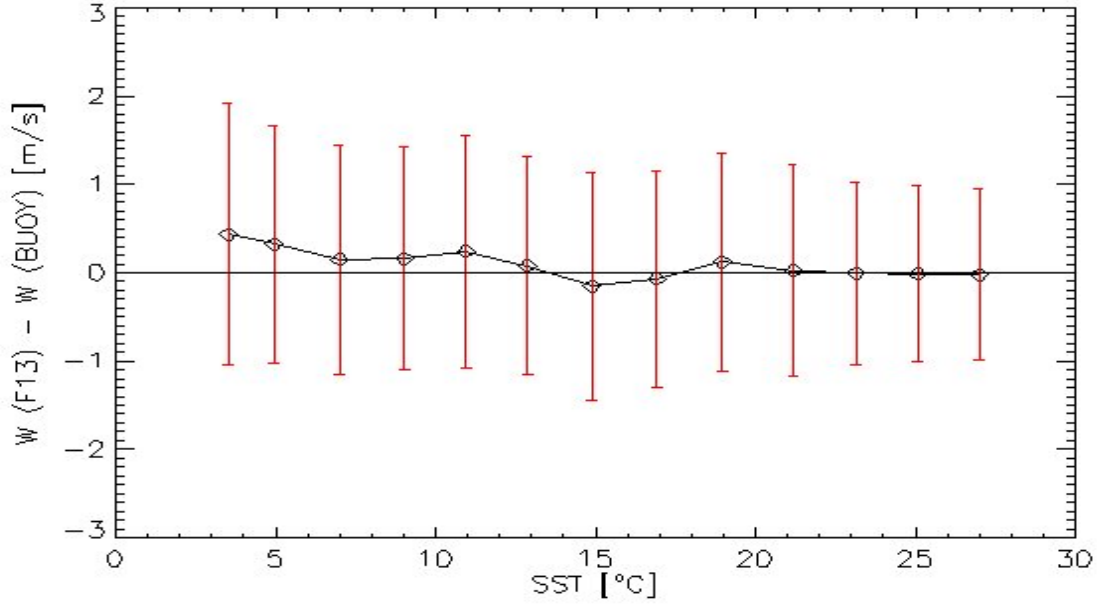
- High Resolution (20 km)
- 18 – 37 GHz channels

Validation

- for existing SSM/I and TMI algorithms
  SSM/I F13 and TMI – Buoy
  (NDBC, TAO, PIRATA networks)
- for CMIS algorithm
  CMIS orbit simulation


W(F13) = 0.9932 * W(BUOY)
W(F13) – W(BUOY):
MEAN: 0.00 m/s
SDEV: 1.07 m/s
W (F13) [m/s]
W (BUOY) [m/s]
0
10
20
30


W (F13) - W (BUOY) [m/s]
W (BUOY) [m/s]
3
2
1
0
−1
−2
−3
0
5
10
15
20


W (F13) - W (BUOY) [m/s]
SST [°C]
3
2
1
0
−1
−2
−3
0
5
10
15
20
25
30

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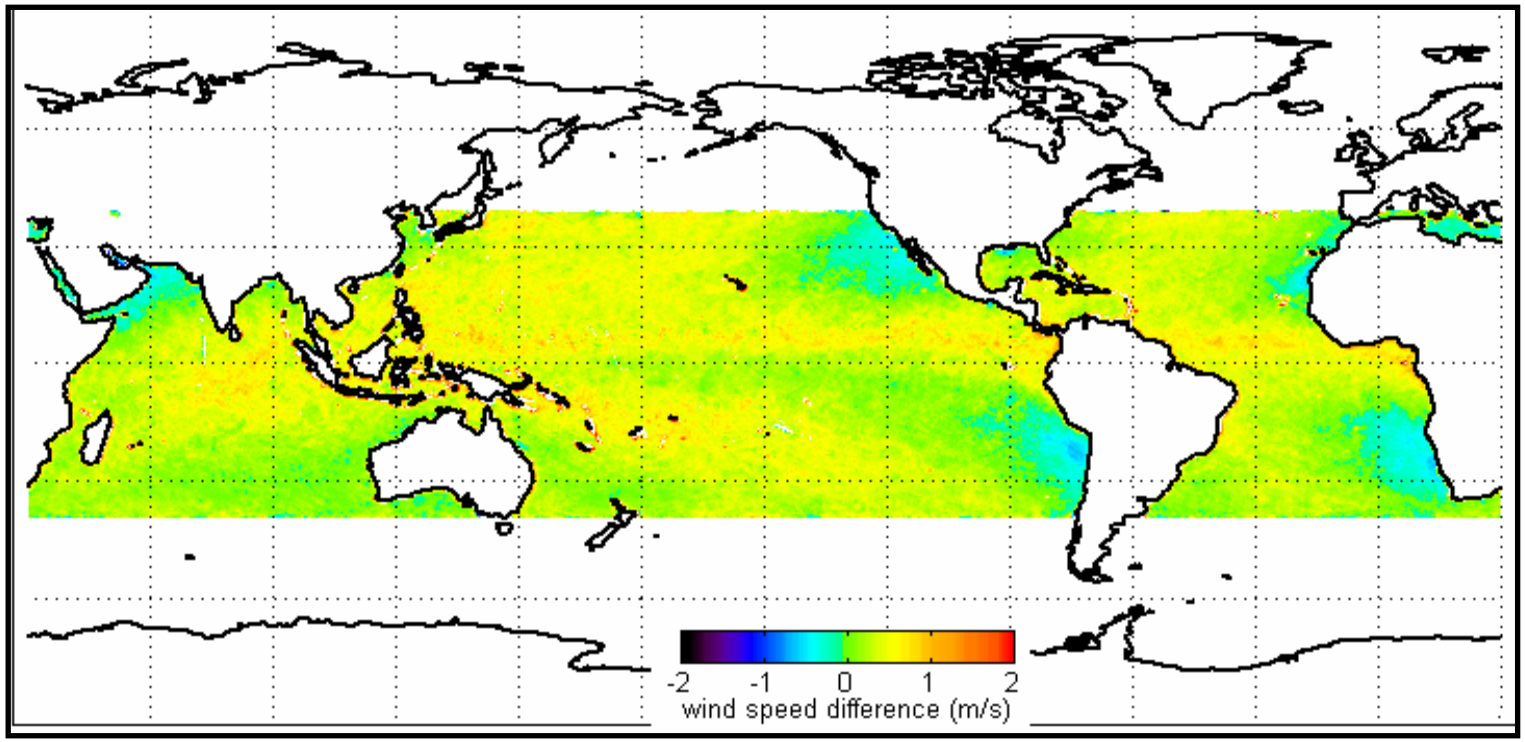
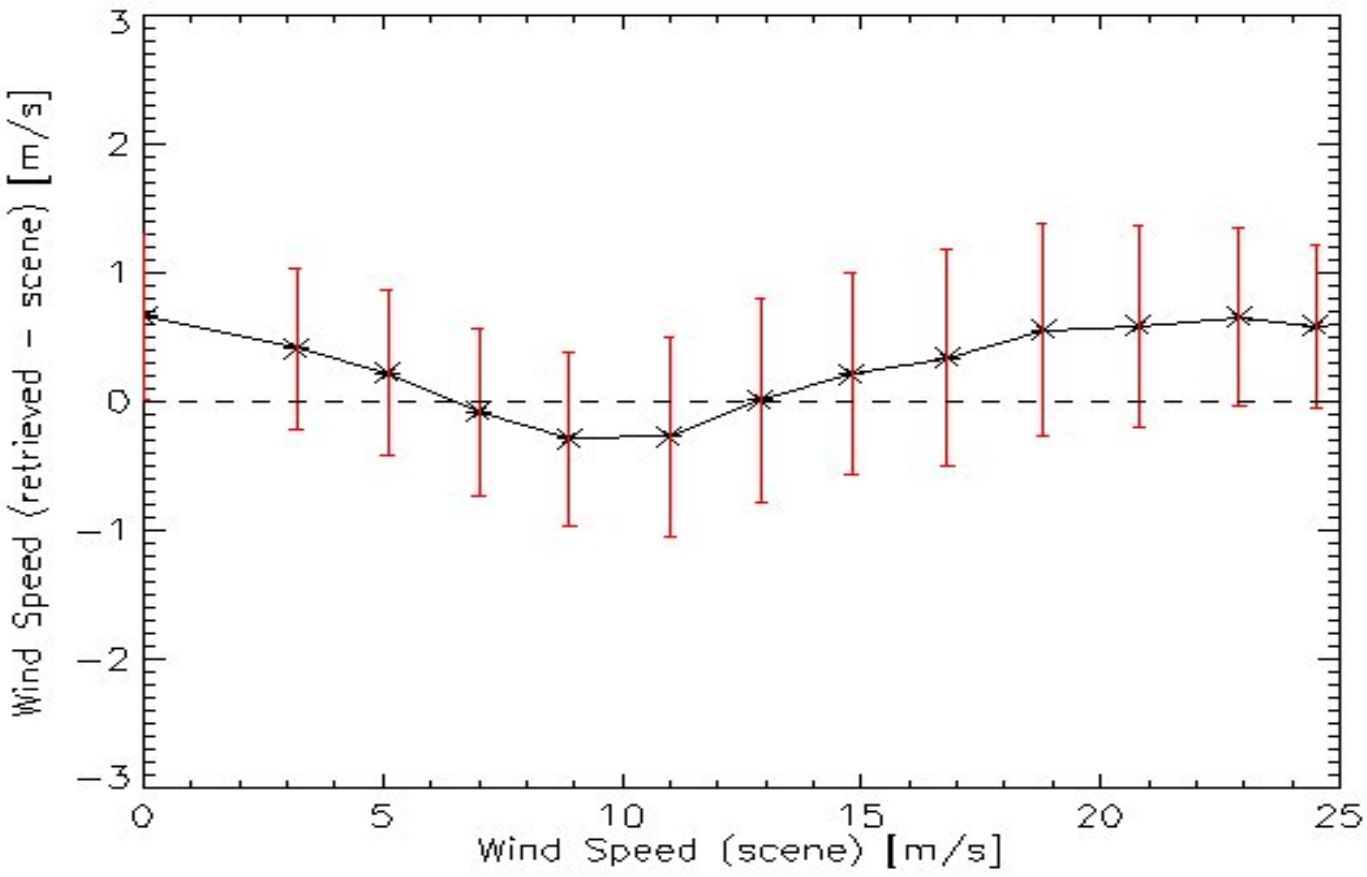
TMI – QuikScat Wind Speed Difference with New Radiative Transfer Model for TMI



CMIS



RMS 1 m/s or better

Wind Direction Retrieval

Direction Signal of Sea Surface Emissivity with respect to wind direction relative to azimuthal look:

- v and h pol

$$E = E_0 + E_1 \cos(\varphi_r) + E_2 \cos(2\varphi_r) + \ldots$$

- 3rd and 4th Stokes Parameter

$$E = E_1 \sin(\varphi_r) + E_2 \sin(2\varphi_r) + \ldots$$

possibility for retrieving wind direction depending on size of the signal with polarimetric radiometers (WINDSAT, CMIS)

Former Analyses

- v and h pol :

Wentz 1992: SSM/I F08 overpasses over 19 NDBC buoys. 3,500 collocations. TB from SSM/I and Wind Vector from Buoys

- 3rd + 4th Stokes Parameter:

Yueh + Wilson 1996: JPL WINDRAD. Aircraft flight over NDBC buoys.

- 2-scale sea surface emission model (Poe + St Germain 1998)

predicted signal which allows wind vector retrieval with polarimetric radiometers for wind speeds > 3 m/s.

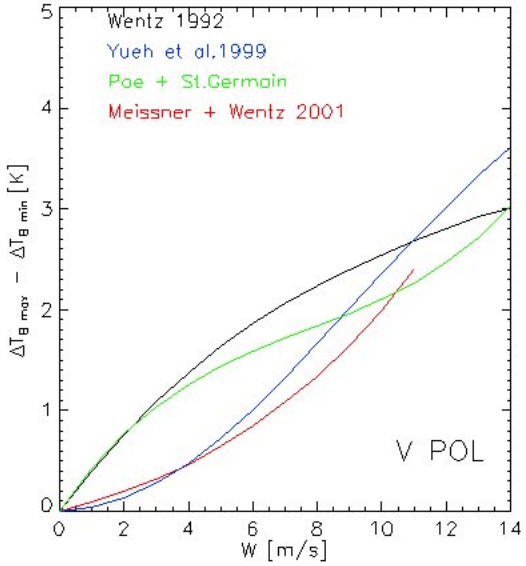
Updated Analysis

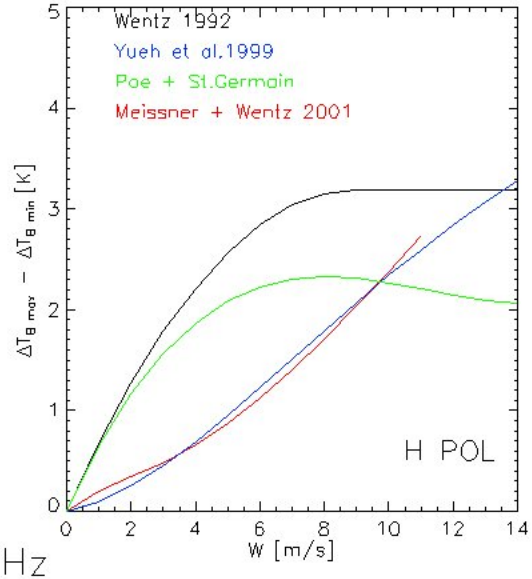
Meissner + Wentz 2001 for v and h-pol:

- Much more data available
- Remove uncertainty in original analysis due to atmospheric fluctuations that are correlated with wind direction (IGARSS Talk: Wednesday 03_03_9:40)

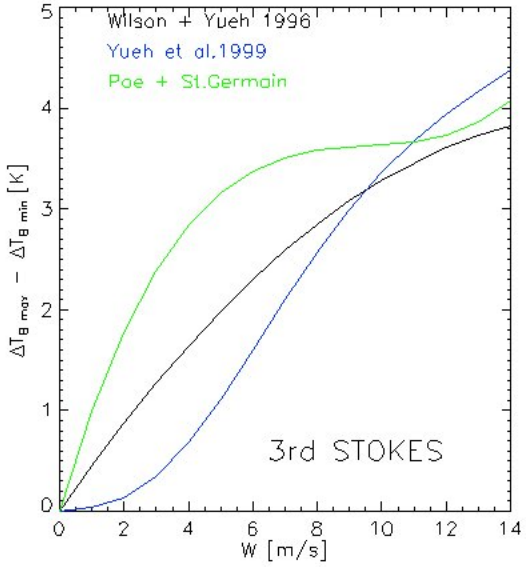
Yueh et al. 1999 for all 4 Stokes Parameters

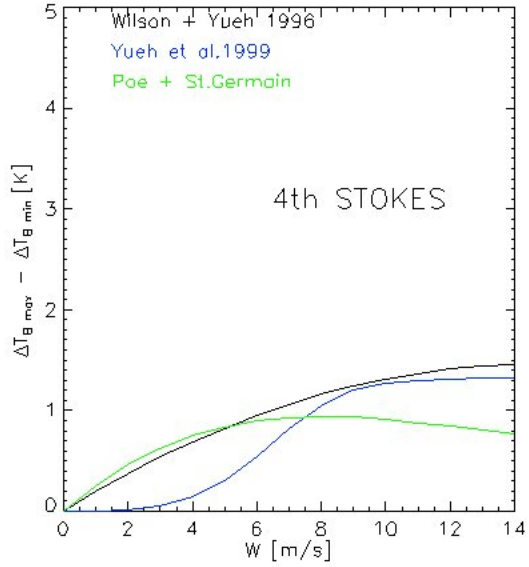
Peak to Peak Amplitude (Max – Min) of Wind Direction Signal





37 GHz





The most recent analyses by Meissner + Wentz 2002 and Yueh et al. 1999 show significantly smaller signals at low and intermediate wind speeds

Final answer on size of wind direction signal by WindSat

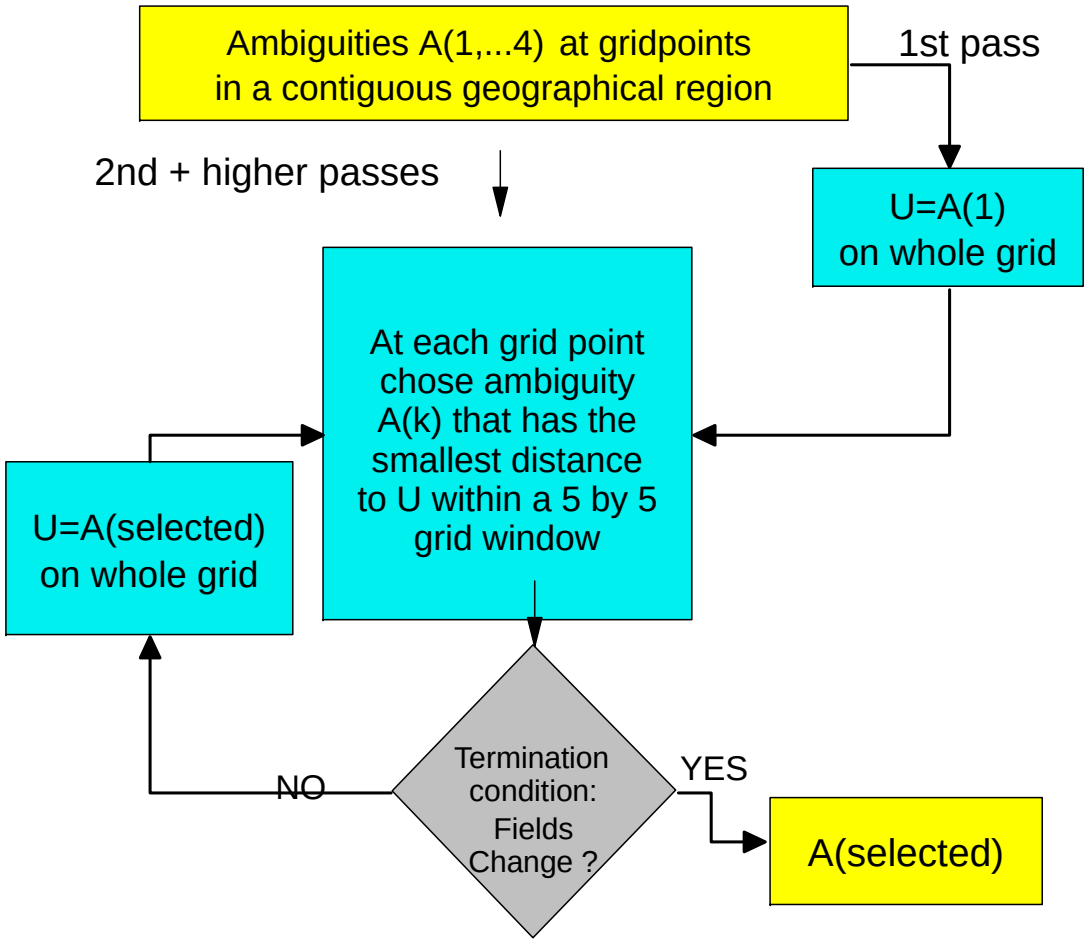
Wind Vector Retrieval Algorithm for CMIS

- Monte Carlo Simulated TB's Orbit-Geolocation + NCEP fields and profiles
- Linear Regression for Sea Surface Temperature and Atmospheric Parameters
- Non Linear Algorithm for Wind Speed and Direction: Minimize Sum of Squares (SOS) between measured TB's and the RTM function, which depends on SST, V, L and the wind vector

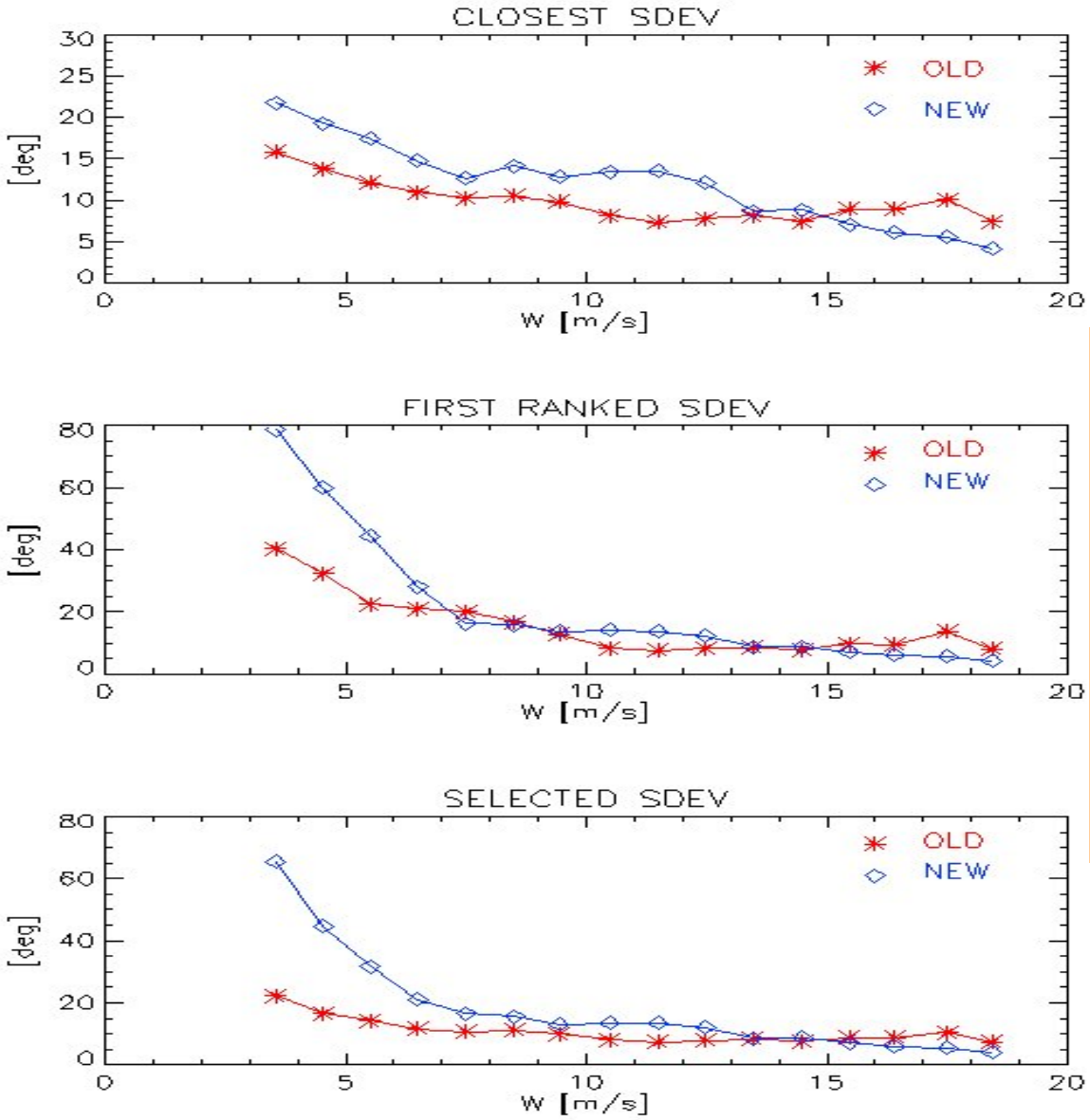
2 - 4 ambiguous wind vector solutions
ambiguity removal (median filter)

CLOSEST: ambiguity closest to the true wind vector.
FIRST RANKED: ambiguity with the smallest SOS
SELECTED: ambiguity selected by Median Filter.

Median Filter



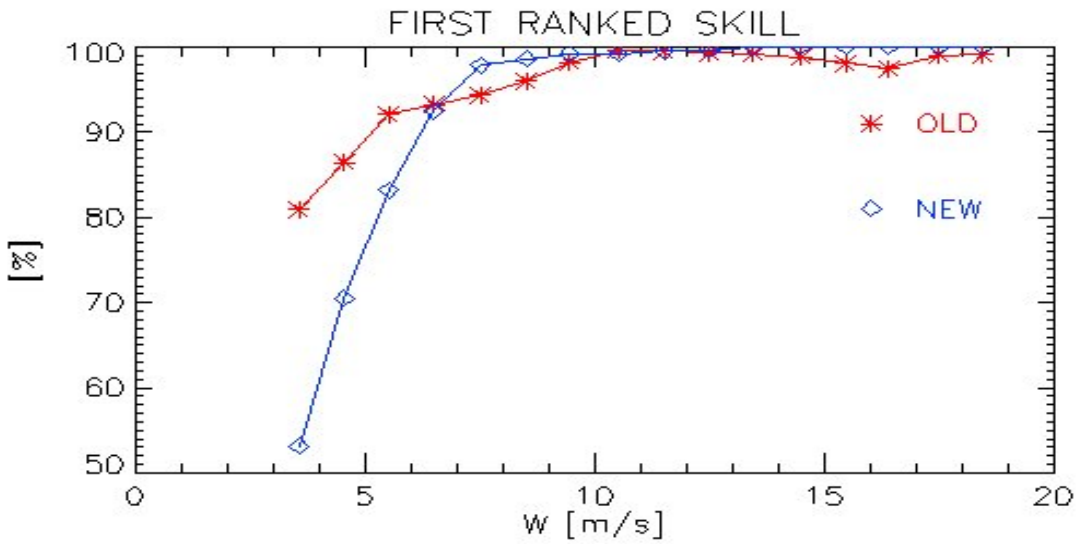
Wind Direction Retrieval Errors

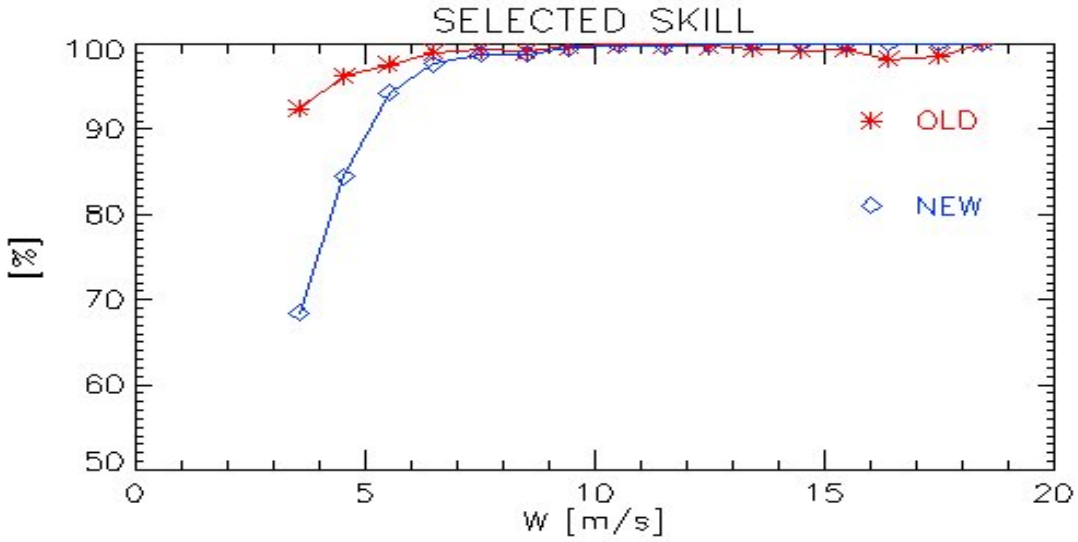


OLD SIGNAL:
Wentz 1992 for v+ h
Yueh + Wilson 1996 for 3rd + 4th Stokes

NEW SIGNAL:
Meissner + Wentz 2001 for v + h,
Yueh et al. 1999 for 3rd + 4th Stokes

Skill Rate





Skill =
Rate, how often first ranked or selected wind fields are identical
to the closest wind field
(best case).

Summary

- SST Algorithm for CMIS expected to perform with RMS of 0.5 K or better over temperature range between 0 and 34^{o}C
- Wind Speed Algorithm for CMIS expected to perform with RMS of 1.0 m/s or better over wind speed range between 1 and 25 m/s.

Wind Direction Retrieval:

satisfactory (20 deg max error) above 10 m/s

problematic for low wind speeds (below 5 m/s)

between 5 and 10 m/s ?